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RADIO NAVIGATION

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[Figures referred to herein are appended.]

The Radio Semicompass (RPK) is a medium-wave aircraft-based radio direction finder with a loop antenna. There are several reasons for the popularity of the RPK: It can operate without interruption, it is easy to operate, it can be used to take fixes on either special or radio broadcasting stations, and two fixes are all that are necessary for determining the position of the plane.

The RPK operates similarly to the land-based RDF, i.e., the loop antenna is turned until minimum reception is obtained. There are certain changes, however, which have been incorporated to make this principle operative for the plane-based RPK. The principal alteration is the presence of a scale with an arrow pointer. The "zero" point is in the center, with graduations to the "left" and "right." This does away with the necessity of determining the point of minimum reception.

The operation of the RPK can best be understood if Figure 1 is studied. The receiver coil D is connected by induction to coil B, thus forming a simultaneous connection with the antenna and coil C of the amplifier. In addition to the high-frequency oscillation received from the amplifier, there is a low-frequency AC voltage (20-100 cycles) generated by a special oscillator M, which acts on the grid of the amplifier. This oscillator, through the transformer coil F, causes an AC voltage to act on the exciter coil G of the indicator which gives either "left" or "right" readings. Another voltage from the receiver output acts on the moving coil K of the indicator which is connected with the arrow pointer.

If the plane of the loop antenna is perpendicular to a line to the station on which the fix is being taken, then there will be no current in the antenna, and there will be only a flow of high-frequency current from the antenna to the receiver input. This is shown in Figure 2. In this case the pointer will not deviate as there is no current in coil E.

If the loop is turned at a slight angle to the right, however, a high-frequency current will appear in coil C. This high frequency will be modulated by the low frequency of the oscillator M. Coil D will be acted on by an EMF from coil C, and also from coil B, and the resulting EMF will be led into the receiver.

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After detection and amplification, there will appear on the output of the receiver a low-frequency current which will act on coil E of the indicator. As a result of these two forces, the arrow will be deflected to the left, as shown in Figure 3.

If on the other hand the loop antenna is turned to the left, the phase of the high-frequency current in the antenna will change 180 degrees, with ultimate result that the low-frequency current in coil E will vary by 180 degrees from that in Figure 3. Consequently, the arrow will be deflected to the right, as shown in Figure 4.

The RPK apparatus has to operate reliably and at a moment's notice. It must therefore be very sensitive to the signals picked up on the antenna. The RPK has 12-16 tubes. But, in spite of its complex construction, it is easy to operate. All that the pilot has to do is to turn the scale ring so that it reads "zero." Since the axis of the antenna is now parallel to the axis of the plane, the pilot has only to turn the plane until the "left-right" indicator reads "zero," showing that the plane is on a straight line to the station on which the fix is being taken. Flying on this type of a fix does away with the necessity of calculating drift as the axis of the plane is always in line on a course to the fix station. Even so, it is true that the plane will not keep a straight course, but will assume a course known as a "dog's path" shown in Figure 5. If the homing station is 300-400 kilometers from the plane, the deviation from a true course will be only 1-2 percent.

The effective range of the RPK apparatus depends on the power and wave length used by the land station. Powerful stations can be used as fixes for distances of 1,000-1,500 kilometers. This distance is greater over open water.

At night, the RPK is unreliable due to errors in taking bearings. These errors will become noticeable at distances of 200-300 kilometers from the homing station. In this case, however, the pilot can take fixes on two stations. There is nevertheless an average error of 3-6 degrees. Such fixes are known as "rough" orientation.

The radio compass (RK) is a further improvement on the RPK. The RPK has the "left-right" indicator, while the RK has a dial graduated to 360 degrees. The needle automatically records the angle showing the deviation of the plane from the direction to the homing station. The RK has the same circuits as the RPK, and in addition has a servo motor which is connected to the loop antenna. The RK, owing to its extremely complex construction, has 16-20 tubes. The RK is attached inside of the fuselage along the axis of the plane, and a dial on the instrument panel repeats the directions determined by the RK. Volume control, sensitivity of the course indicator, and switching on and off of the compass can all be done by manipulating dials on the instrument panel. The rotation of the loop antenna is also recorded on the instrument panel. It is thus possible to determine the relation of the antenna's axis to the plane's axis.

The antenna is attached either on top or on the bottom of the fuselage, and along the axis of the plane. This symmetrical installation is necessary to secure balanced clearance between the metal parts of the plane which otherwise will cause slight errors in the compass readings due to the reflection of some of the transmitted radio waves. Consequently, the direction of the antenna is not always exactly parallel to the straight-line course to the homing station. This angle of deviation can, in extreme cases, be as much as 15-20 degrees. These deviations are constant for each individual plane. It is therefore recommended that each plane equipped with RPK or RK have on board a "deviation chart." Therefore to obtain correct bearings on stations, it is necessary to either add or subtract from the readings on the graduated scale.

The following is the recommended procedure for making a fix on a homing station: (1) Select a radio station and pick it up on the receiver. (2) Activate the compass mechanisms. The dial on the instrument panel will point either "left"

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or "right." (3) Turn the loop until the course indicator points to "zero" (minimum of the loop). (4) Take a reading on the graduated scale and make corrections using "deviation charts." (5) Add the magnetic compass reading, compass deviation, and local magnetic declination to the figure obtained in (4). (6) Add 180 degrees to obtain a back azimuth. (7) With the aid of a protractor, enter the back azimuth on the chart. The projection of this angle from the transmitting station will be the "position line of the plane." (8) Similar operation for Station No 2.

The above-mentioned procedure should take 3-4 minutes. If an RK is available, the time can be cut to 1-2 minutes.

[Appended figures follow.]

Figure 1

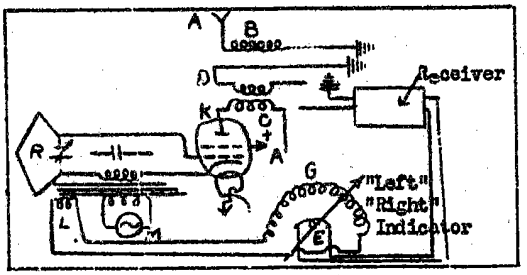

Figure 2

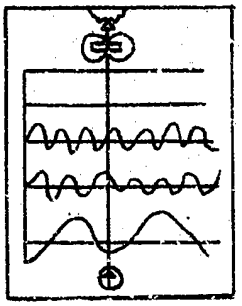

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Figure 3

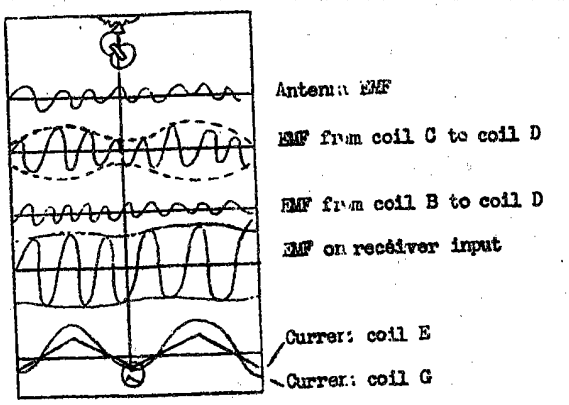


Figure 4

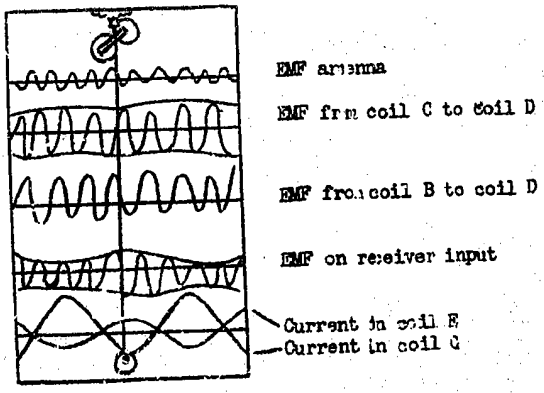
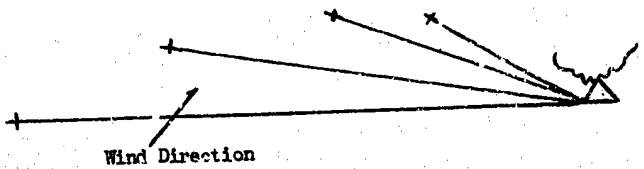


Figure 5



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